Sorensen
POWER SUPPLIES

instruction manual for STM SERIES MODULAR DC POWER SUPPLIES

INCLUDES THE FOLLOWING STM MODELS:

MODULE III		MODULE IIIA	
3.5-24	18-10	3.5-36	18-15
5-24	24-8.5	5-36	24-13
9-12	28-7	9-20	28-11
12-12	36-4	12-20	36-6
15-10	48-4	15-15	48-6

SORENSEN COMPANY
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676 ISLAND POND ROAD MANCHESTER, NEW HAMPSHIRE 03103

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1 INTRODUCTION

1.1 PURPOSE

This manual contains operation and maintenance instructions for the STM series of high efficiency modular dc power supplies, manufactured by the Sorensen Company, Manchester, New Hampshire. The STM models included in this manual are similar in electrical design and physical appearance. They are grouped into two module sizes; III and IIIA, differing only in size and in power output ratings. (Refer to Table 1-1, Unit Specifications.)

1.2 GENERAL DESCRIPTION

The STM series provides a variety of highly regulated dc outputs and is designed for operation on 115 Vac or 150 Vdc. The line also offers exceptionally high efficiency and fast recovery times as well as characteristically low output impedances.

The supplies are designed for mounting in any of three attitudes; end, bottom or side. Four tapped mounting holes are provided on each side. Section 2 provides necessary installation data.

1.3 FUNCTIONAL DESCRIPTION

Operational features of the STM series power supplies include remote sensing (regulating), remote programming, overload and short-circuit protection by automatic current-limiting, and over-voltage protection through an integral electronic crowbar shorting circuit.

1.3.1 Remote Sensing

For applications where variation in the load-lead voltage drop may adversely affect load regulation, remote sensing may be used to establish the regulating point at the load rather than at the output terminals.

1.3.2 Remote Programming

The STM series power supply outputs may be altered from a remote location by either the resistance or the voltage programming methods. For resistance programming, a calculated value of resistance at the ratio of 1000 ohms/volt is inserted in the programming network. For voltage programming, a value of voltage at the ratio of 1:1 is inserted.

1.3.3 Series Operation

For applications requiring output voltages higher than a single unit can provide, STM units may be connected in series to a maximum total of 200 Vdc. Regulation in series operation is the sum of the regulations of all units.

1.3.4 Parallel Operation

Consult factory for requirements.

1.3.5 Over-Current Protection

In the event of an excessive current condition, such as a short-circuit, a current-limit circuit acts to reduce the unit output voltage. This circuit is factory-set to at least 115% of the unit rated output current at 40°C (+104°F).

1.3.6 Over-Voltage Protection (OVP)

In the event of an over-voltage condition on the output, such as a failure in the power supply or an externally induced condition, an over-voltage electronic crowbar is actuated by an integral OVP sensing circuit. The crowbar acts to quickly reduce the output voltage to zero and to disable the input dc circuit.

1.4 ACCESSORIES

Several universal rack-mount adaptors are availfor the STM series. For specific information on these adaptors, contact your service representative, or the factory.

Table 1-1A Common Specifications

Input Rating:	AC: 105-132 volts, 50-440 Hz, single phase DC: 150 Vdc, ±15%
Maximum Input Current:	Nominal Input Voltage: 115 Vac / 150 Vdc Module III Amperes: 4.0 / 1.9 Module IIIA Amperes: 5.5 / 3.2
Recommended Fuse, @ Nominal Input Voltage:	Module III: 6 Module IIIA: 8
Output Ratings: Efficiency Voltage Regulation Ripple, RMS Ripple, P-P Temp. Coefficient Turn-ON/OFF overshoot Transient Response Remote Programming Output Impedance:	To 75% 0.05% (combined line and load) 3 mV maximum (10 mV on 3.5/5-volt models)* 50 mV maximum (typically 30 mV) 0.01% per °C None (output voltage) 1.0 millisecond for half-load change/return to 1% band 1000 ohms per volt (resistance)/1V:1V (signal) Typically less than 0.005 ohm @ 10 kHz 0.01 ohm @ 50 kHz 0.015 ohm @ 100 kHz 0.02 ohm @ 500 kHz
Current Limit:	Automatic, internally adjustable from zero to 125% of rated full-load current. Factory set to approximately 115% of rated (40°C) current. (See individual unit specification.)
Over-voltage (OVP) Limit:	Automatic, adjustable crowbar action, self-contained. Factory-set at 1V or 10% of nominal output voltage. (See unit specifications.) Reset requires cycling input power. (Allow 30 seconds for discharge of input capacitors.) OVP action is delayed (typically) by approximately 100 microseconds to avoid nuisance tripping. Resolution of OVP adjust 0.1% of output voltage rating (typical). OVP stability 2% of voltage trip setting for all conditions (typical).
EMI (RFI):	Designed to meet most portions of MIL-STD-461A.
Stability:	After one hour warm-up, 0.05% for 24 hours with all external effects held constant.
Resolution:	0.05% of output voltage maximum. (See individual unit specifications.)
Parallel Operation:	Consult factory.
Series Operation:	To 200 Vdc maximum.
Remote Sensing:	The voltage drop per load lead is constrained only by the maximum rated unit output voltage. (For example, 5-volt nominal STM supplies have an E_O maximum of 6.0 volts. Thus, operating at an output of 5 volts allows a total of 1 volt total lead drop, or 0.5 volt per load lead.)
Ambient Rating:	0 to 71°C/32 to 160°F. (See current ratings in unit specifications.)
Cooling:	Natural convection.
Dimensions (inches): Width Height Depth	Module III: 5-1/8 / 3-5/16 / 9-1/2 Module IIIA: 5-1/8 / 3-5/16 / 14
Weight (lbs):	6-1/2 / 9
Volume (cu. in.):	160 / 238
Input-Output Connections:	All connections are made to a 7-terminal barrier strip using #5-40 screws.

Note: Specifications valid at 50/60Hz. At higher input frequencies, ripple may be greater.

Table 1-1B Unit Specifications Module III

Model No.	3.5-24	5-24	9-12	12-12	15-10	18-10	24-8.5	28-7	36-4	48-4
Output Ratings (dc):										
Nominal Voltage (V)	3.5	5.0	9.0	12.0	15.0	18.0	24.0	28.0	36.0	48.0
Voltage Range (V)	3.0-4.5	4.5-6.0	6-10	9.5-13.5	13-17	16-20	19-25	24-30	29-43	42-56
Regulation (mV)	1.75	2.5	4.5	6.0	7.5	9.0	12.0	14.0	18.0	24.0
Current (A);										
@ 40°C	24.0	24.0	12.0	12.0	10.0	10.0	8.5	7.0	4.0	4.0
@ 50°C	19.4	19.4	9.7	9.7	8.1	8.1	6.8	5.6	3.2	3.2
@ 60°C	14.9	14.9	7.5	7.5	6.2	6.2	5.3	4.3	2.5	2.5
@ 71°C	9.6	9.6	4.8	4.8	4.0	4.0	3.4	2.8	1.6	1.6
Current Limit (Adc) Factory set to;	27.6	27.6	13.8	13.8	11.5	11.5	9.8	8.0	4.6	4.6
Over-voltage Limit (Vdc) Factory set to;	4.5	6.0	10.0	13.2	16.3	19.8	26.4	30.8	39.6	52.8
Input Ratings (Typ.) Efficiency (%)	60	64	66	70	68	72	73	73	71	75
Output Adjust Resolution (mV)	2.25	3.0	5.0	6.75	8.5	10.0	12.5	15.0	21.5	28.0

Table 1-1C Unit Specifications Module IIIA

Model No.	3.5-36	5-36	9-20	12-20	15-15	18-15	24-13	28-11	36-6	48-6
Output Ratings (dc):										
Nominal Voltage (V)	3.5	5.0	9.0	12.0	15.0	18.0	24.0	28.0	36.0	48.0
Voltage Range (V)	3.0-4.5	4.5-6.0	6-10	9.5-13.5	13-17	16-20	19-25	24-30	29-43	42-56
Regulation (mV)	1.75	2.5	4.5	6.0	7.5	9.0	12.0	14.0	18.0	24.0
Current (A);										
@ 40°C	36.0	36.0	20.0	20.0	15.0	15.0	13.0	11.0	6.0	6.0
@ 50°C	29.1	29.1	16.2	16.2	12.1	12.1	10.5	8.9	4.8	4.8
@ 60°C	22.3	22.3	12.4	12.4	9.3	9.3	8.0	6.8	3.7	3.7
@ 71°C	14.4	14.4	8.0	8.0	6.0	6.0	5.2	4.4	2.4	2.4
Current Limit (Adc) Factory set to;	41.4	41.4	23.0	23.0	17.3	17.3	15.0	12.7	6.9	6.9
Over-voltage Limit (Vdc) Factory set to;	4.5	6.0	10.0	13.2	16.3	19.8	26.4	30.8	39.6	52.8
Input Ratings (Typ.) Efficiency (%)	60	64	66	70	68	72	73	73	71	75
Output Adjust Resolution (mV)	2.25	3.0	5.0	6.25	8.5	10.0	12.5	15.0	21.5	28.0

2 INSTALLATION

2.1 GENERAL

After unpacking, general inspection and preliminary check-out procedures should be performed to assure that the unit is in proper working order. If it is determined that the unit has been damaged, the carrier should be notified immediately. Repair problems may be directed to the nearest Sorensen representative, or to the Service Department, Sorensen Company, Manchester New Hampshire.

2.2 INSPECTION

Check for damage incurred during shipment as follows:

1. Inspect enclosures for dents, chips and other obvious signs of damage.
2. Check condition of external terminal board. Make certain that all terminal screws are in place and that links are fitted over the barrier strips between terminals 1 and 2, and between 3 and 4.
3. Inspect fuse holders for evidence of damage.
4. If internal damage is suspected.
   a. Remove all flat-head retaining screws from around the perimeters of the case assembly.

NOTE

For Module IIIA units, it is only necessary to remove the top (and one side) of the casing.

   b. Remove the round-head screws from the rear panel and remove the case.
   c. Inspect the components and printed circuit board (PCB) for damage.
5. Check that the power transistors are firmly plugged into their sockets. These are readily removable for servicing.

2.3 INPUT CONNECTIONS

STM units are shipped ready for use with either 115 Vac or 150 Vdc.

NOTE

For either connection, fuse F1 is in series with the input line connected to TB1 pin 7. Maximum circuit protection is provided when the high side of the input line (the black wire in standard ac connections) is connected to this pin.

2.4 ELECTRICAL CHECK

CAUTION

Before applying power to the unit, it is important that input/output isolation be checked. This may be done using a VOM set to the x 10 K scale. Assure maximum resistance from input at TB1-6 and -7 to case (ground), and output at TB2-1 to case. It is recommended that this measurement be performed each time the unit case is removed and replaced.

To perform an initial electrical check, proceed as follows:

1. Make certain that unit is located in an area where free passage of air is unrestricted. Connect input leads to terminals TB1-6 and -7 (IN). Use terminal 5 (GRD) for input system ground.
2. Connect a dc voltmeter across terminals TP1-1 and -4 (OUTPUT SENSING). Select a voltage range compatible with rated output.
3. Apply nominal rated input power.
4. Rotate output adjust sufficiently to swing the dc voltmeter from minimum rated voltage to nominal output voltage per Table 1-1. (Adjustment to 1 volt or 10% higher than nominal output will trip the OVP.)
5. Set output voltage at its nominal value and remove input power.

2.5 MOUNTING

STM units may be mounted in a variety of positions and locations, including rack mounting.

NOTE

Specific data for rack mounts is avail-

able at the factory. Fabricate knockout panels as shown in Figure 2-2. Figure 2-1 is an overall outline drawing of the STM modules.

1. For cantilever-type mounting from a vertical panel or wall (where free access to vertical airflow is available):

   End mounting - Use knockout per Figure 2-2. This knockout clears the terminal block and fuses.

   Side or bottom mounting - No knockout is needed. Use the four mounting holes shown in Figure 2-2.

2. For flat mounting from a horizontal surface (where free access to vertical airflow is not available):

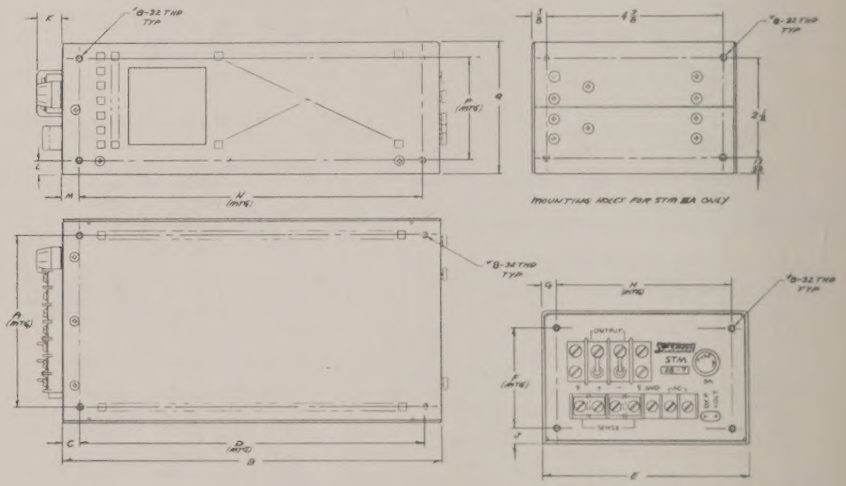
   End mounting - Not recommended.

   Side mounting - Module III units, see knockout per Figure 2-2. Module IIIA units may be mounted directly with no knockout required.

   Bottom mounting - Use knockout per Figure 2-2.

3. Vertical panel mounting per paragraph 1 preceding is preferred since maximum airflow is assured. Horizontal surface mounting per paragraph 2 preceding, using bottom mounting with proper knockout is the second preference.

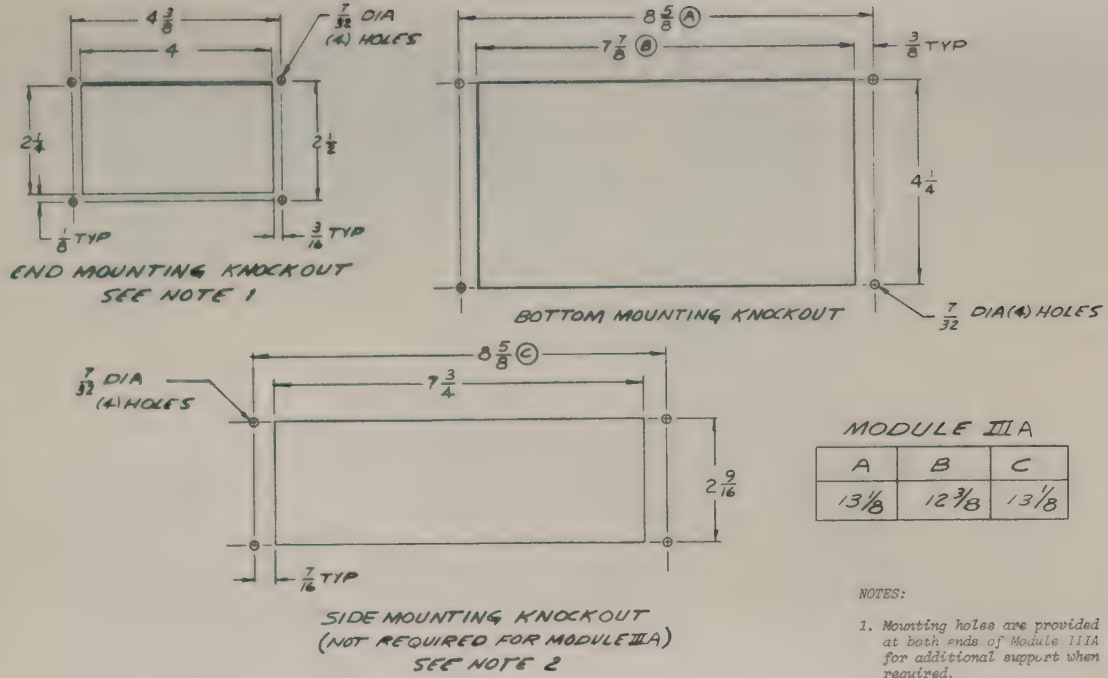
4. Mounting screws should be No. 8-32 and just long enough to penetrate 1/4 inch into the STM unit and through the mounting surface with lock/flat washers used.



UNIT	DIM A	DIM B	DIM C	DIM D	DIM E	DIM F	DIM G	DIM H	DIM J	DIM K	DIM L	DIM M	DIM N	DIM P	DIM Q
STM III	4-1/4	9-1/2	7/16	8-5/8	5-1/8	2-1/2	3/8	4-3/8	13/32	11/16	3/8	7/16	8-5/8	2-9/16	3-5/16
STM IIIA	4-1/4	14	7/16	13-1/8	5-1/8	2-1/2	3/8	4-3/8	13/32	11/16	3/8	7/16	13-1/8	2-9/16	3-5/16

D586791 REV A

Figure 2-1
Outline Drawing, STM modules III and IIIA



MODULE IIIA

A	B	C
13 1/8	12 3/8	13 1/8

NOTES:

1. Mounting holes are provided at both ends of Module IIIA for additional support when required.
2. For Module IIIA, mount directly. No knockout required.

Figure 2-2 Knockout Dimensions, STM Modules III and IIIA

3 OPERATION

3.1 GENERAL

This section contains instructions on how to adapt the unit to, and operate it in, a number of varied applications. These include remote sensing, remote programming, and series operation.

CAUTION

1. *The sensing and power circuits form a closed loop. Opening this loop, either by removing a terminal board link or disconnecting a sensing or programming lead will result in a high unit output and will cause the OVP crowbar to operate.*

2. *Continuous operation with an input less than 85 Vac will damage the unit.*

3.2 CONTROLS

STM units are equipped with two controls; the output adjust and the OVP adjust potentiometers. The output adjust control R26 is used to vary the output voltage while the OVP adjust control R14 is used to vary the OVP trip point. Both are factory-set to nominal values (see Table 1-1).

3.3 PRE-OPERATION CONSIDERATIONS

3.3.1 Current Limiting Setting

The current-limiting point is factory-set to approximately 115% of rated 40°C current. This limit will vary inversely with input line changes. For ambients beyond 40°C, rated output current is derated per Table 1-1, and the limit setting should be reset accordingly. To avoid current limiting due to line and/or temperature variations, unit operating current should be 15% of rated current below the limit setting.

3.3.2 Current Limit Reset

To reset the current limit proceed as follows:

1. Rotate limit adjust control R38 on A100 printed circuit board (PCB) fully clockwise (CW).

2. Connect a voltmeter across output terminals TB1-1 and -4. Apply nominal input power and adjust output voltage control (R26) for the unit's rated nominal value.

3. Remove input power and connect an ammeter and variable load resistor in series across the output terminals.

4. Reapply input power and adjust load so that the test ammeter indicates current limit determined in paragraph 3.3.1.

5. Rotate R38 on the A100 PCB slowly counterclockwise (CCW) until both output voltage and current begin to drop.

6. Remove input power, disconnect test instruments and load. Replace top cover.

3.3.3 Over-Voltage Trip Point

The OVP trip point is factory set to 1V or 10% (whichever is greater) higher than the rated nominal output voltage (Table 1-1). However, if the output voltage will be operated near its maximum rating, it may be desired to raise the trip point. For nuisance-free OVP, the trip point should be maintained at least 1V or 10% (whichever is greater) above the operating voltage. For example, a 5V model operating at 5.5V should use a 6.5V trip setting.

3.3.4 OVP Trip Point Reset

To reset the OVP, proceed as follows:

1. Rotate OVP control (R14) on panel fully CW.

2. Rotate output control (R26) on panel until the output voltage is equal to the desired trip point.

3. Rotate OVP control R14 slowly CCW until the output voltage suddenly drops to zero. This indicates OVP has triggered the crowbar.

4. Remove the input power. Rotate output control CCW. Allow approximately 30 seconds for unit to discharge.

5. Apply input power. Reset output until desired operating voltage is obtained.

NOTE

The OVP circuit includes a time-delay network such that the over-voltage (OV) condition must exist for approximately 100 microseconds before the OVP fires. This delay prevents short-duration OV pulses from triggering the crowbar.

3.3.5 Reset After OVP Fires

If the OVP fires, proceed to reset the circuit as follows:

1. Remove input power and disconnect load (in case OV condition is externally induced). Allow approximately 30 seconds for unit to discharge.

2. Rotate output adjust R26 fully CCW (minimum voltage).

3. Apply input power and raise output voltage to desired value.

If the OVP again trips, internal failure is indicated, or the output is set too close to operating voltage (see 3.3.4 preceding).

3.4 LOCAL SENSING

The unit is shipped ready for use in the local-sensing mode. In this mode, regulation is at the output terminals, not at the load. If variations in load-line voltage drops are expected to be prohibitive, refer to paragraph 3.5, remote sensing.

To operate the unit, proceed as follows:

1. Connect a voltmeter across output sense terminals TB1-1 (+) and TB1-4

2. Attach the input leads to terminals TB1-6 and -7. Use terminal 5 (GND) to ground input system.

3. Apply nominal input power.

4. Rotate output adjust until desired output voltage is indicated on voltmeter.

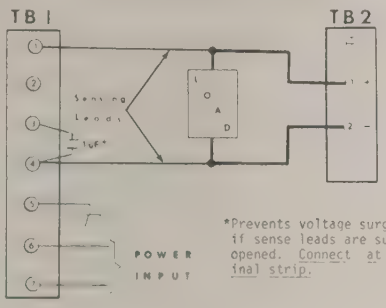
5. Remove input power, disconnect voltmeter and connect load leads to terminals TB2-1 and -2. Do not remove or loosen any of the interconnectin links. Apply nominal input. Unit supplies highly regulated power to load.

WARNING

Do not touch unit's heat sink while unit is operating under load. Surface temperature is comparatively high. If unit must be handled immediately after operation, wear heat-resistant gloves.

3.5 REMOTE SENSING

If it is desirable to sense (regulate) unit output at the load rather than at output terminals, remove the links between terminals TB1-1 and -2, and TB1-3 and -4. Run a sensing lead from terminal TB1-1 to the positive side of load; connect the other lead from terminal TB1-4 to the negative side of load (see Figure 3-1). Sensing leads should be fabricated using a shielded, twisted pair of wires. Set unit in operation per paragraph 3.4. Do not exceed maximum rated output.



*Prevents voltage surge if sense leads are suddenly opened. Connect at terminal strip.

Figure 3-1
Remote Sensing Connections

3.6 REMOTE PROGRAMMING

The unit may be programmed to supply pre-determined output voltages by inserting a calculated resistance into the voltage-sensing circuit. Programming sensitivity is approximately 1000-ohms-per volt; that is 1000 ohms are required for each volt difference between the desired output and the minimum value of the unit's specified range. The program resistor should be a 1/8-watt (or larger) precision film resistor with a 25 PPM/°C coefficient (ecual to MIL style RN55E). The programming current is approximately 1 milliampere. However, a 1.0 uF capacitor in parallel with the inserted programming resistor is required to prevent the unit from oscillation.

To adapt the unit for remote programming, proceed as follows:

1. With normal local sensing (paragraph 3.4), set power to ON and adjust output to specified rated minimum output voltage (see Table 1-1 for specific model). For example, for a 12V module, set the output to 9.5 volts.

2. At this point, any value within rated output range (Table 1-1) can be obtained by inserting 1000 ohms-per-volt difference between the desired voltage and the minimum voltage. For example, to obtain 12.0-volt output in the above example, the difference is 12.0 (-) 9.5 or 2.5 volts. The program resistor should be 2.5 x 1000 or 2.5K ohms.

3. Parallel the program resistor with a 1.0 uF capacitor.

4. Set power to OFF. Remove the link from TB1-3 and -4 and connect programming resistor in its place. Note that either local or remote sense can be used.

5. Apply input power and verify load voltage across terminals TB2-1 and -2 as the desired value (using local sense).

3.7 SERIES OPERATION

Series operation is utilized for the purpose of obtaining a higher output voltage than available from a single model. Two supplies may be connected in series to form a dual polarity (+) & (-) output system such as (±) 12V with a common return. Any amount of bridging load may be tolerated.

3.8 PARALLEL OPERATION

Consult factory if it is desired to operate SYM units in parallel.

4 THEORY OF OPERATION

4.1 BASIC STM PRINCIPLES (Refer to Figure 4-1; block diagram)

STM circuitry incorporates 20-kHz switching techniques, contributing to high efficiency and exceptional power density (high power output capability and small physical size).

The basic circuit consists of a 20-kHz push-pull, pulse width modulated inverter operating directly from the rectified ac line. The inverter output is rectified and filtered in a double L-C filter, and the resultant dc output voltage is sensed and compared with a reference voltage. Any difference, or error voltage is amplified and fed back to the inverter to control the pulse width. Thus a closed loop is achieved, resulting in excellent line/load regulation.

4.2 CIRCUIT DESCRIPTION

4.2.1 Input Circuits (Refer to schematic diagram, Figures 5-2/5-3)

Input power is full-wave rectified through diode bridge CR1 (or CR1-CR4 as applicable) and filtered by C1 and C2. Approximately 150 Vdc (depending on the input line variations) appears across capacitor C2, on which is superimposed a 120-Hz component (twice the line frequency). This dc voltage establishes the operating level of push-pull inverter T1/Q3/Q4, and through pre-regulator A200, a regulated 110 Vdc input for bias inverter T1/Q2/Q3 on printed-circuit board A100 (reference Figure 5-6B).

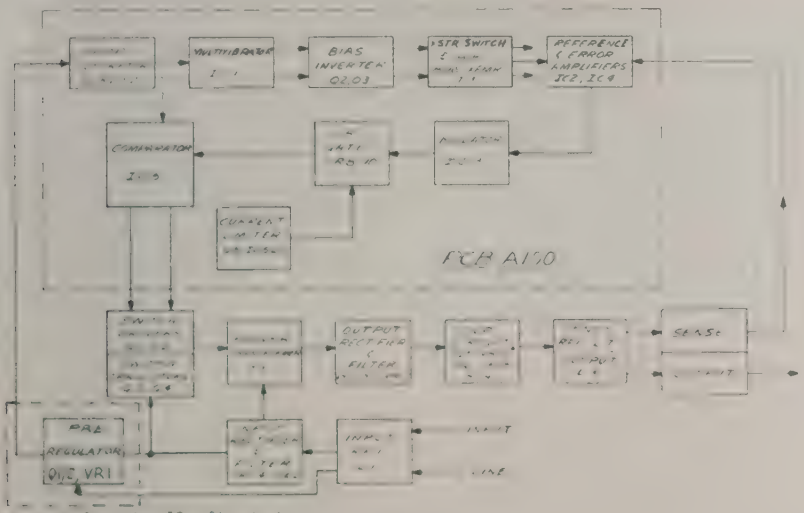
4.2.2 Ramp Generator Circuit (Figure 5-6)

The ramp generator, consisting of (A100) Q1, C2, and R2, is designed to operate at a repetition rate of 40 kHz, and serves as the master "clock" for the power supply.

Capacitor A100C2 charges at a pre-determined rate until its voltage reaches a level established by A100VR4. At that point, programmable unijunction transistor (PUT) A100Q1 fires, resetting the ramp generator. The ramp output is fed to comparator circuit A100IC5, and a trigger pulse, developed across A100R3, is fed to the multivibrator circuit at IC1E.

4.2.3 Multivibrator and Bias Supply

The multivibrator (MV) circuit provides a square-wave output at 20 kHz (just half of the ramp generator trigger pulse repetition rate) which sup-



* On units less than 15-volt output.

Figure 4-1
STM Simplified Block Diagram

plies the base drive for bias inverter transistors (A100) Q2 and Q3. (A100) Q2 and Q3 in turn drive the primary of bias supply transformer A100T1.

The dc operating voltage (150V from the input circuit) is applied at P1-6 to MV IC1 at a reduced level of approximately 12V, determined by (A100) VR1, VR2 and associated circuitry. During turn-on the MV will free-run and produce a 15-kHz square wave. Once the bias circuit reaches proper operating level, the ramp generator functions, and the MV is driven at a 20-kHz rate by the trigger pulses at A100IC1E. At that point, bias transformer A100T1 is operating with a 20-kHz square wave on all windings:

The three separate secondaries of A100T1 function as follows:

1. Pins 4-6; develop bias voltages for the ramp generator, comparator, and current limiter A100Q5 and associated circuitry.

2. Pins 7-9; supply base drive current for main switching transistors Q3 and Q4 through Q1 and Q2 on the chassis assembly.

3. Pins 10-12; provide bias for reference and error amplifier circuitry (A100) IC2, IC4 and associated components.

4.2.4 Comparator and OR Gate

The comparator circuit consists primarily of integrated circuit (IC) components (A100) IC5A, B, and C. The comparator compares the relatively constant output of the ramp generator (at the base of IC5C) with the variable output of the OR gate, consisting of diodes (A100) CR8, 9, and 10, at the base of IC5A. The resultant comparator output pulse at IC5B is amplified through (A100) Q6 and Q7 simultaneously, and fed to switch driver transistors Q1 and Q2 on the chassis assembly.

The OR gate takes the larger of three inputs and passes it on to the comparator.

The inputs are as follows:

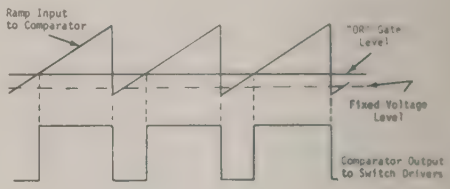
1. A fixed voltage at (the anode of) A100CR8 developed by (A100) VR4, R29, and R30.

2. The error amplifier output at A100-CR9, through isolator A100IC3B.

3. The current-limiting circuit output developed at A100CR10.

In a typical operating situation, any tendency of the supply output to increase is sensed through error amplifier A100IC4. This output controls the OR gate through (A100) IC3 and CR9, increasing the gate output to the comparator and thus narrowing the width of the pulse which controls the ON time of switches Q3/Q4.

This function is illustrated in the following diagram:



The fixed voltage at A100CR8 establishes a maximum pulse width (minimum OR output) allowable, to protect switching transistors Q3 and Q4. Wider pulses might conceivably overlap, damaging transistors Q3 and Q4 by switching both ON at the same time.

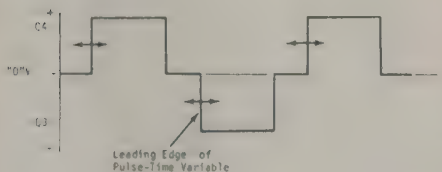
4.2.5 Switching Transistors

As noted previously, switching transistors Q3 and Q4 react to the output of the comparator through their respective drivers Q1 and Q2. This input rectangular wave, with a 40-kHz repetition rate is fed simultaneously to the bases of Q1 and Q2. Only one will be activated however, as the collectors of each are connected to secondary 7, 8, and 9 of bias transformer A100T1. Thus, while one is turned ON (+5 volts), the other will be at cut-off (-5 volts). Since the transformer waveform is 20 kHz, synchronized with the comparator, alternate comparator outputs are fed to Q1/Q2.

The comparator thus turns on the appropriate drive transistor, which in turn activates switching transistors Q3 or Q4. Turn-off of Q3 and Q4 is accomplished by diodes CR5 and CR10 in conjunction with bias transformer A100T1. This action results in very rapid turn-off of the switching transistors.

4.2.6 Output Circuits (Figures 5-2/5-3)

The switching action of Q3/Q4 results in the following string of pulses at the primary of transformer T1. (Pulsewidtn determined by ramp vs. OR gate output).



At the secondary, rectification takes place through CR11 (and CR19/20 where used). The resultant signal at a 40-kHz repetition rate, is then filtered by L4/C9, and L5/C10, and appears as the supply output voltage at TB2-1 (+) and TB2-2 (-). The integration function of the filtering reduces the 40-kHz component of the output to less than 3 millivolts.

4.2.7 Reference and Error Amplifiers (Figure 5-6)

Integrated circuits IC2/IC4 on PCB A100 are the primary components of the reference and error amplifiers respectively. The circuits derive operating power from secondary windings 10, 11, and 12 of bias transformer A100T1. The waveform at the secondary is rectified by (A100) CR4/CR5, and filtered by A100C9. Integrated circuit A100IC2 functions as a voltage regulator, and produces a constant 16 Vdc from pins 7 (+) to 6 (-). This regulated voltage is used to bias error amplifier A100IC4, and more importantly, A100VR3, which is the primary voltage reference diode for the supply. The anode of VR3 is connected to the unit positive sense terminal (TB1-1) through R22 and L7 (A) on the main chassis.

In a stable condition of supply operation, terminals 3 and 4 of error amplifier A100IC4 will be at zero volts. With the input bias to IC4 at less than 0.1 microampere, the voltage across A100R26 is essentially at zero. Using these basic assumptions, the voltages at P1-1 and P1-2 will be at zero, and thus the current noted at P1-1 is the sum of those through (A100) R24/25. Potentiometer A100R23 has been adjusted to maintain this current at 1.0 milliampere (the unit programming current). This level remains constant until an error (change) voltage is sensed at the supply output. The programming current thus appears at A100IC4 pin 2, and at negative sense terminal TB1-4 through R23/R25/L7B on the main chassis. A100IC4 pin 3 is connected to positive sense terminal TB1-1 through A100R26, and R22 and L7 (A) on the main chassis.

Any variation in output voltage is instantly sensed at the error amplifier, and processed through isolator A100IC3 to an arm of the OR gate, and through the comparator. Then, as described in paragraph 4.2.4, switching pulses are widened or narrowed as required to counter-react variations in output voltage. Diodes (A100) CR6/CR7 act to protect the error IC circuit from large variations in output voltage.

Thus is formed a negative feedback loop consisting of: error amplifier, isolator, OR gate, comparator, switching transistors, T1 (main chassis) and output rectifiers and filters. Compensation is provided in the negative sensing circuit by C18/R24 together with (A100) C11/R22 to ensure that the loop remains free of oscillations.

4.2.8 Current Limiting Circuit (Figure 5-6)

This circuit, consisting of (A100) Q5, IC5D, CR12 and C15 serves to protect the supply in the event of excessive current demands such as a short-circuited output. By design, a fixed relationship exists between the unit output current and the peak current of switching transistors Q3/Q4. Therefore, by limiting Q3/Q4 peak current, the output current is controlled.

The peak voltage across R5 on the main chassis (due to Q3/Q4 switching current) is applied to peak charging circuit (A100) C15/CR15 through P1-12/-5 on the PCB connector. The capacitor charge, then, is proportional to both peak switching and dc output currents. A reference (threshold) voltage is developed by (A100) VR4, R38/R34 and appears across A100R35. When the voltage at A100C15 exceeds a critical value established by this threshold, A100IC5D, and consequently A100Q5, (acting as an error amplifier) conducts. This action causes the A100CR10 arm of the OR gate to take control of the feedback loop (current limit mode), producing whatever voltage is necessary to restrict

the supply output current.

A100CR12 acts as a temperature-compensating diode between the base-emitter junction of NPN transistor A100IC5D, adding temperature stability to the circuit.

4.2.9 Over-Voltage Protection (OVP) Circuits (Figures 5-2/5-3)

The OVP circuit senses an over-voltage condition at the output terminals, and acts to fire diode CR18, momentarily shorting the output voltage. Either of two circuit designs are used, depending on the level of output voltage. Both are analyzed in the following paragraphs.

4.2.9.1 Supply Outputs to 12 Volts

For these lower voltage supplies, regulator VR1 establishes the over-voltage reference level. Its bias is set by C8/CR12, CR13/CR14, and Q5. A sample of this reference appears across potentiometer R14, and presented through temperature-compensating diodes CR15/16 to the gate of programmable unijunction transistor (PUT) Q6. Also at the anode of Q6 is a sample of the output voltage. When this sample exceeds the reference sample at the gate of Q6 by more than approximately 300 mV, Q6 fires, and with it, CR18. Simultaneously, CR1 on PCB A100 is fired through transformer T2, acting to shut down bias inverter A100 Q2/Q3. This has the effect of shutting off switches Q3/Q4 on the main chassis. This condition remains until the line voltage is removed.

4.2.9.2 Supply Outputs of 15 Volts and Greater

For these STM supply outputs, Q6 is a silicon unilateral switch (SUS), used as a triggering device. This device utilizes an internal voltage as the over-voltage reference. When its anode/cathode voltage exceeds this level (approximately 7.5 Vdc), it fires, abruptly reducing its voltage. As the circuit current increases, CR18 fires, shorting the output voltage. Unit shut-down occurs through the T2/A100CR1 action described in the previous paragraph.

4.2.10 Radio Frequency Interference (RFI) Control

The switching action of this type of supply might be expected to create a source of RFI. The design of the STM series has minimized this interference, using the limits specified in MIL-STD 461A as a reference.

Conducted interference on the input lines is reduced to acceptable levels by L1/L2/L3 together with C3/C4 on the main chassis. Conducted interference at the output load and sense leads is minimized by L6/L7 and C13/C14. Radiated interference is effectively minimized by the metal enclosure of the STM series power supplies.

5 SERVICE AND REPAIR

5.1 GENERAL

This section provides unit troubleshooting data, and calibration and performance-testing procedures. The troubleshooting data should be used in conjunction with the schematic diagrams (Figures 5-2/5-3), location photos (Figures 5-4/5-5), and previous Section 4 which outlines the theory of operation. Questions pertaining to repair should be directed to the nearest Sorensen service representative or to the Service Dept., Sorensen Company, 676 Island Pond Road, Manchester, N.H. 03103. Include the model and serial numbers in any correspondence. Should it be necessary to return a unit to the factory for repair, authorization from the Sorensen service dept. must first be obtained. Sorensen Company will not assume responsibility for units returned without prior authorization.

Unit troubleshooting hints are provided in Tables 5-1 and 5-2 in the form of SYMPTOM/PROBABLE CAUSE/REMEDY. Where practicable, step-by-step procedures are used to facilitate isolation of a problem area.

Care should be taken when replacing any component, even if it appears obviously defective. A failed component is generally the result of a malfunction elsewhere in the system. It is the purpose of this troubleshooting procedure to help isolate both the failed component and the cause of its failure.

5.2 PERIODIC SERVICING

The STM models require no periodic servicing. However, when a unit is taken off the line it is recommended that the enclosure be inspected and cleaned of any accumulations of dust or other debris which could impede the free flow of air through the unit.

5.3 TEST EQUIPMENT REQUIRED

Use the test equipment listed (or an equivalent)

1. Oscilloscope, dual trace, 20-MHz bandwidth, isolated from ground. (Tektronix 454 with 10X voltage probe for channel A.)

2. 50-ohm, 2-watt load (in series with channel B and current probe).

   Channel B; current probe (Tektronix P6042)

3. Differential voltmeter (Fluke 845)

4. Differential voltage probe (Tektronix P6046)

5. RMS voltmeter (Hewlett Packard HP-3400A)

6. VOM (Simpson 260)

CAUTION

1. *Assure that all test equipment used while troubleshooting is NOT GROUNDED. Use an isolation transformer wherever practicable.*

2. *Each time the unit is opened, re-check for input and output isolation to case ground before turn-on.*

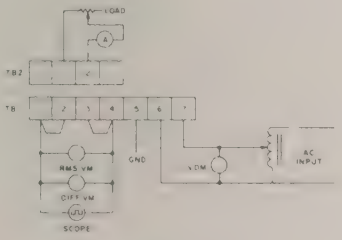


Figure 5-1
Test Equipment Setup

5.4 TROUBLESHOOTING

5.4.1 General Considerations

Before attempting repairs, the STM unit should be carefully inspected for apparent defects, such as broken or damaged components/connectors or PCB, or for obvious heat damage or loose pin connections.

After replacing an electrical component, the simulated turn-on procedure outlined in paragraph 5.5.1 should be performed before placing the unit into service.

The physical size and shape of a replacement part can have an effect on the performance of the power supply. The part should therefore be a direct replacement whenever possible. Section 6 of this manual lists replaceable parts along with the Sorensen part numbers as applicable.

5.4.2 Switching Transistors (Q3/Q4)

CAUTION

The casings of these transistors are "live" during operation.

In the event power transistors Q3 and/or Q4, require replacement, the probable cause of failure should be determined before power is applied to the unit. Proceed as follows: (Use test equipment per paragraph 5-3).

1. Remove the case screws of both Q3 and Q4, isolating the collectors from the circuit.
2. With a VOM set to the R x 1 scale, measure an open circuit from Q4 emitter (-) to Transformer T1, black lead (+).
3. Check for line-to-chassis isolation. Read open circuit on VOM set to R x 10K scale.
4. With the VOM, check the drive circuit components for a possible short.

NOTE

After the cause of failure has b[illegible] nated, proceed to simulated turn-o[illegible] [illegible].

5.4.3 Over-voltage Protection [illegible]

Failure in the OVP circuit can generall[illegible] to an improper adjustment of OVP potentiometer (R14), or one of the following:

1. For units up to 12-volts [illegible]; CR12, Q5, VR1, Q6, CR18, or an associated component, (Figure 5-2).
2. For units with 15-volts (or greater output; Q6, CR18, or an associated component, (Figure 5-3).

After replacing any component in this section, the OVP should be properly set as outlined in final turn-on procedure (paragraph [illegible]). If OVP continues to actuate, proceed to [illegible] troubleshooting in paragraph 5.4.4.

Table 5-1 Main Chassis Troubleshooting

SYMPTOM	PROBABLE CAUSE	REMEDY
1. No output	A. Over-voltage protection circuit tripped (fuse intact). *NOTE* *Indication of OVP tripping is a high-pitched whistle, audible 30 seconds after unit power is removed. If whistle occurs sooner, the OVP circuit probably has not been tripped.*	1) Reapply input voltage after approximately 30 seconds. 2) Verify proper setting of OVP trip point (R14, accessible through front panel). CW adjustment increases the output voltage trip point. If this adjustment resolves the problem, reset R14 per paragraph 3.3.4 in Section 3 of this manual. 3) If OVP tripping recurs with normal output loading, or with no output, refer to OVP troubleshooting procedure (paragraph 5.4.3).
	B. Current limit improperly adjusted.	If, during unit calibration or repair, potentiometer R38 on PCB A100 has been left in the fully CCW position, no output will appear. Refer to final turn-on procedure (paragraph 5.5.2).
	C. Output circuit shorted (fuse not affected).	Check individual output circuit components.
	D. Input fuse open.	1) Replace fuse. 2) For repetetive fuse failures, perform the following checks as necessary. a. Remove power and replace fuse. b. Connect a VOM (Simpson 260 or equivalent) set to the R x 1 scale between the transistor case (+) and emitter (-) of Q4 (Figures 5-2/5-3). A normal indication is an open circuit condition. If this occurs, continue to paragraph c. following. If a short is indicated (less than 15 ohms), remove the (Q3 and Q4) transistor case screws, which will isolate the collector(s) from the circuit. Repeat the resistance test for each transistor, collector to emitter. A short indicates a faulty transistor. Replace as necessary. *NOTE* *After replacing Q3/Q4, do not yet insert Q3/Q4 case screws until the probable cause of failure has been determined. Refer to Q3/Q4 troubleshooting, (paragraph 5.4.2).* c. Check for shorted input rectifier (CR1-CR4) as applicable. d. Check for short from input to chassis (TB1-6 or -7 to TB1-5). e. Connect the VOM across input terminals TB1-6 and -7. Remove the A100 control card. If the short is eliminated, proceed to the control PCB troubleshooting procedure (paragraph 5.4.4).

Table 5-1 Main Chassis Troubleshooting (cont'd)

SYMPTOM	PROBABLE CAUSE	REMEDY
1. No output (cont'd)	D. Input fuse open. (cont'd)	f. Check for continuity: (Refer to applicable schematic diagram, Figure 5-2/5-3). 1. Positive line output of rectifier CR1 (or CR1/CR2 cathodes as applicable) to; T1 (black lead) and R14 on A100 PCB (P1-6). 2. Negative line output of rectifier CR1 (or CR3/CR4 anodes as applicable) to; Emitter of Q4, and P1-5 on A100 PCB.
	E. Input circuit failure.	Remove case (collector) screws of transistors Q3 and Q4. Proceed to simulated turn-on procedure in paragraph 5.5.1.
2. High output	Improper setting of voltage adjust (R26) and OVP adjust (R14), accessible at front panel.	1) Reset R26 and R14 per paragraph 5.5.2 steps 6 through 11. 2) Check for continuity from J1-1 to TB1-4, and J1-2 to TB1-1. (See Tables 6-1 or 6-2 for proper resistance values.)
3. Low output	A. Current limit improperly adjusted.	Readjust per final turn-on procedure (paragraph 5.5.2).
	B. VR3 on PCB A100.	Refer to control PCB troubleshooting, paragraph 5.4.4.
4. Excessive ripple on output	A. Low line input.	Monitor input line voltage.
	B. L5 & L6 defective.	Visually inspect for signs of deterioration or damage.
	C. C10 malfunctioning or defective.	1) Check for proper tightening of C10 hold-down screws. 2) Check C10 for short/open.
5. Poor regulation	A. Measuring across load terminals	Regulation must be measured across sensing terminals.
	B. Unit overload.	Load not to exceed maximum rated current specification.
	C. Current limit improperly adjusted.	Refer to adjustment procedure in paragraph 5.5.2.
	D. Control PCB A100.	Check PCB per paragraph 5.4.4
	E. Faulty preregulator PCB	Check for 100 Vdc output (Figure 5-8).

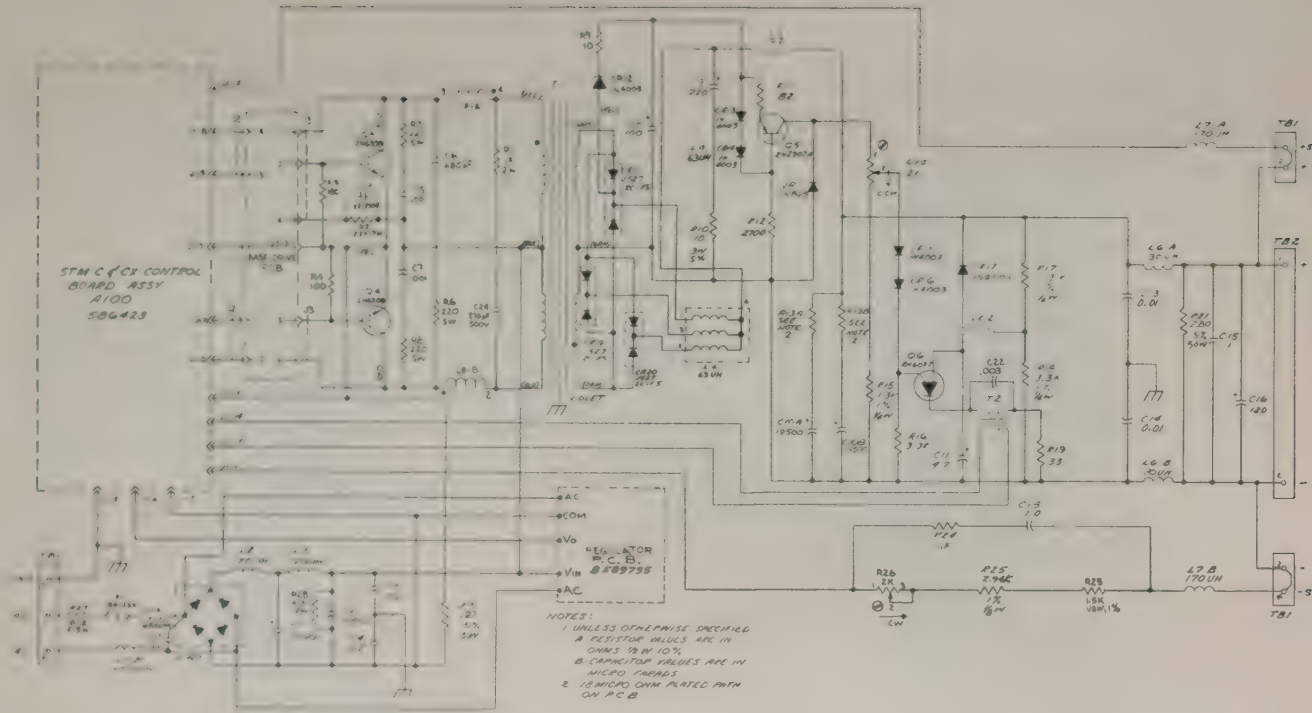


Figure 5-3 STM3-12-Volt Units
Typical Schematic Diagram

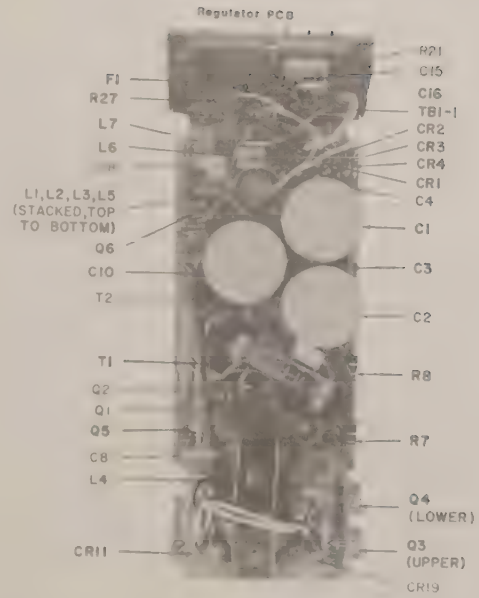


Figure 5-4 Module III-Typical Component Location Photo

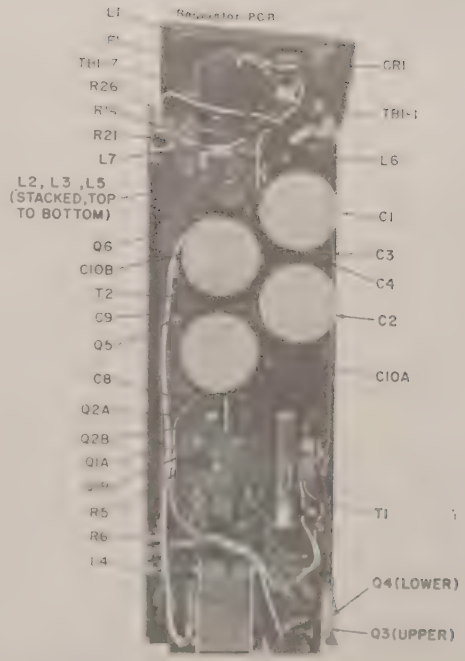


Figure 5-5 Module IIIA-Typical Component Location Photo

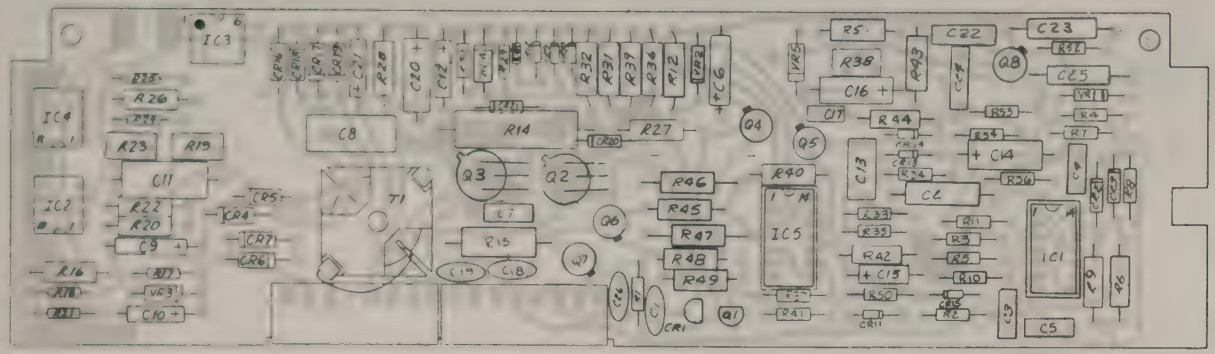


Figure 5-6A (A100) Printed-Circuit Board Assembly

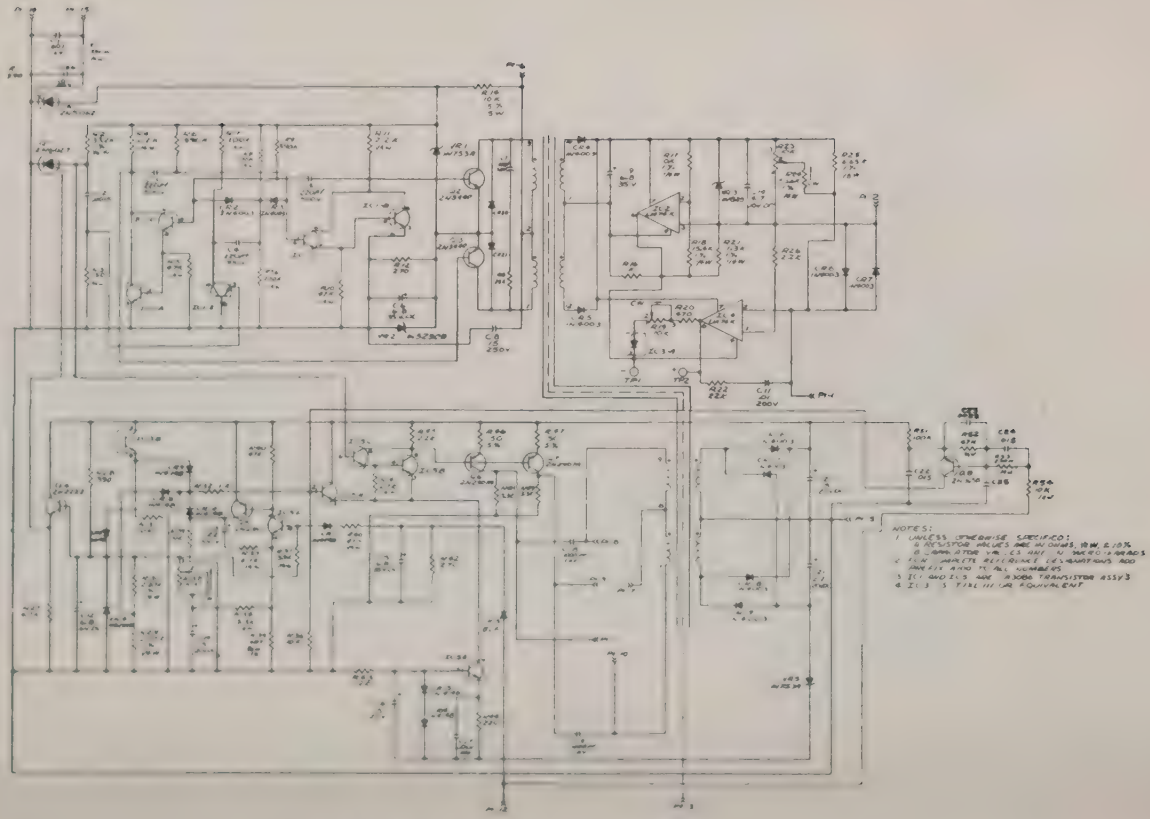


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Figure 5-6B (A100) Printed-Circuit Board
Schematic Diagram

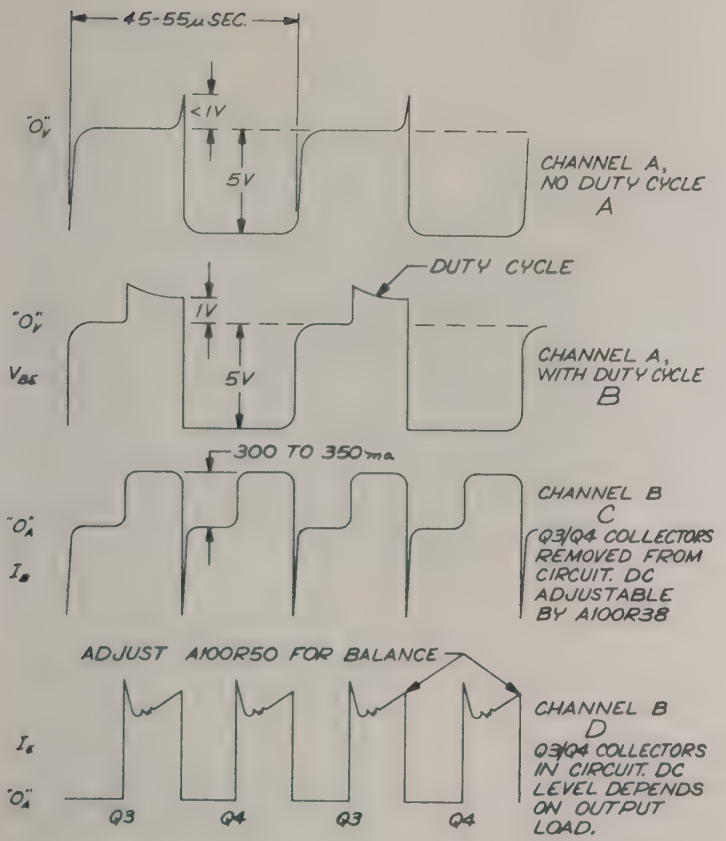
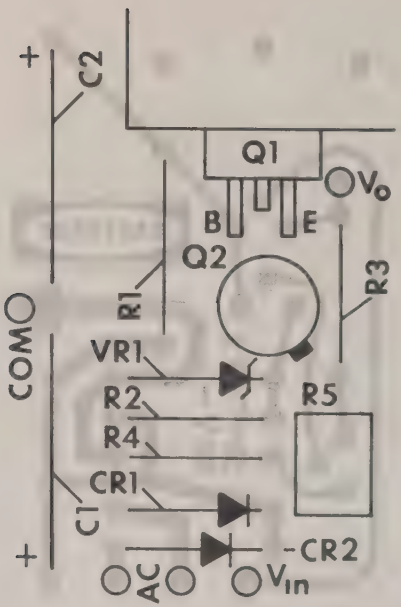


Figure 5-7 Switching Transistor Waveforms



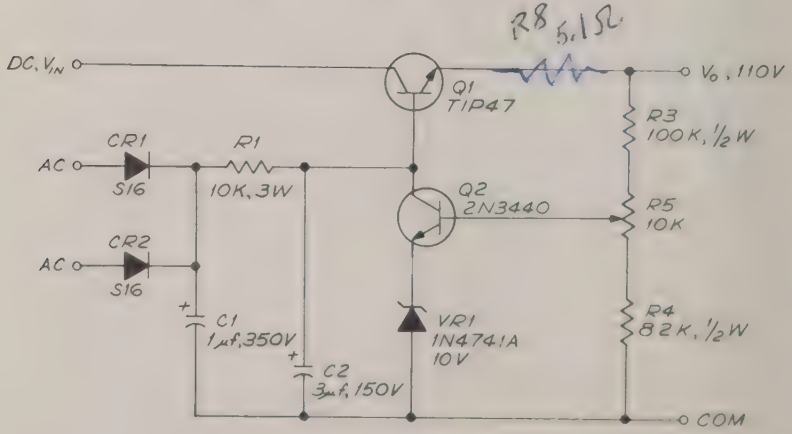


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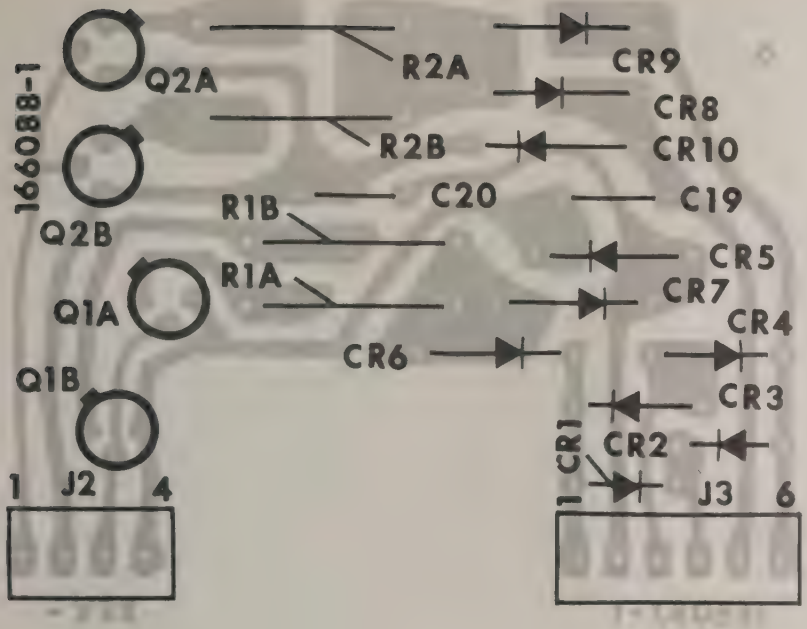
Figure 5-8
Regulator Printed-Circuit Board
Schematic and Assembly
Drawings



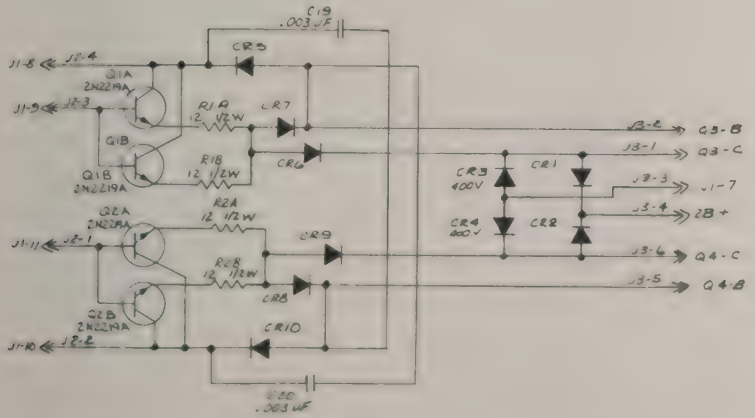


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Figure 5-9
Base Drive Printed-Circuit Board
Schematic and Assembly Drawings

6 REPLACEABLE PARTS LISTS

6.1 INTRODUCTION

This section provides a coded replaceable parts list, keyed to the schematic diagram and parts location diagrams appearing in Section 5. All Module III models are covered by Table 6-1; all Module IIIA models are covered by Table 6-2.

Tables 6-3/6-4 summarize the replaceable electrical parts for the STM Control and Regulator printed-circuit boards. These boards are compatible with all models in module groups III and IIIA. Module IIIA units contain a current-limiting printed-circuit board, with replaceable parts as listed in Table 6-5.

Figures 5-6A, 5-8, and 5-9 (Section 5) illustrate the component layout for these boards.

6.2 TABLE HEADINGS DEFINED

6.2.1 Used-On Code (U/O)

This code number (1 through 10) identifies those models using a component of a particular value. A part common to all models will be listed 1-10 in the U/O column.

Table 6-1 lists the replaceable parts for the following STM models:

Model	U/O Code	Model	U/O Code
3.5-24	1	18-10	6
5-24	2	24-8.5	7
9-12	3	28-7	8
12-12	4	36-4	9
15-10	5	48-4	10

Table 6-2 lists the replaceable parts for the following STM models:

Model	U/O Code	Model	U/O Code
3.5-36	1	18-15	6
5-36	2	24-13	7
9-20	3	28-11	8
12-20	4	36-6	9
15-15	5	48-6	10

6.2.2 Reference Designation (Ref Des)

This is an alpha-numeric identification of the component as called out on the schematic diagram.

6.2.3 Sorensen P/N

This number should be used when ordering parts direct from:

Sorensen Company
Distribution Center
25 Industrial Road
Grenier Industrial Village
Londonderry, N. H. 03063

6.2.4 Mfr., Type

This is the basic group or series under which the part is listed by a manufacturer. The coded identification of representative manufacturers are summarized below, listed alphabetically.

Mfr. Code	Manufacturer
AB	Allen Bradley Co.
AM	Ammons Instrument Co.
AX	Acushnet Capacitor Co.
BNS	Bourns, Incorporated
BUS	Bussman Mfg./Div. McGraw-Edison
CD	Cornell-Dublier Corp.
CG	Corning Glass Works
CL	Clarostat Corp
CTS	CTS Corporation
ELA	Electra/Midland
EMC	Electromotive Manufacturing Co.
GE	General Electric Co.
GI	General Illuminating Co.
IND	Industrial Devices
IRC	International Resistance Co.
KEM	Kemet Division Union Carbide Corp.
KC	Keystone Carbon
LF	Littelfuse Corporation
MA	Motorola
MAL	P. R. Mallory Co.
NS	National Semiconductor
RAM	RAM Electronics
RCA	RCA Corporation
RCL	RCL Electronics
RDM	Radio Material Co./Div. P.R. Mallory
SAN	Sangamo Electric
SE	Seacor, Incorporated
SEM	Semtech Corporation
SP	Sprague Electric
SR	Sorensen Company
ST	Solitron Devices
STM	STM Corporation
TEL	Teledyne Semiconductor Division
TI	Texas Instruments
UC	Union Carbide
WH	Westinghouse Semiconductor Division
WL	Ward Leonard

5.4.4 Control PCB A100

Select required test equipment from the recommended list in paragraph 5.3. Assure that any equipment used is not grounded.

Refer to Figure 5-6 for schematic diagram and location of components; proceed with troubleshooting as outlined in Table 5-2..

CAUTION

1. Remove the switching transistor Q3/Q4 case (collector) screws before troubleshooting the control PCB.

2. After repair or replacement of PCB, continue to simulated turn-on procedure in paragraph 5.5.1.

5.5 OPERATIONAL CHECKOUT PROCEDURES

Whenever a component is repaired or replaced, the appropriate unit turn-on procedure should be followed before placing the unit into service:

1. Input failure (including PCB A100): perform first the simulated turn-on procedure in paragraph 5.5.1 (transistor case screws removed) and then the final turn-on procedure paragraph 5.5.2 (screws re-inserted).

2. Output failure: perform final turn-on procedure (paragraph 5.5.2).

5.5.1 Simulated Turn-On Procedure

With the casing (collector) screws removed from transistors Q3/Q4 proceed as follows: (Use the test equipment outlined in paragraph 5.3).

1. With input power OFF, set the current limit control A100R38 fully CCW.

2. Connect the VOM, set to the R x 100 scale, positive lead to the primary terminal (black lead) of power transformer T1, negative lead to the Q3/Q4 emitter (yellow wire). Note the capacitor charge current.

3. Connect the VOM, set to the R x 1 scale, to the output terminals; positive to positive and negative to negative, and note the resistance. Meter will indicate a bleeder resistance according to the unit under test. (See parts list in Section 6 for resistance values.) Reverse the polarity of the VOM. Read forward biased

Table 5-2 Control Board A100 Troubleshooting

SYMPTOM	PROBABLE CAUSE	REMEDY
1. No unit output	Multivibrator circuit	Replace IC1, VR2, C2 and Q3. Check for open/shorted T1 bias transformer primary (normally 12 ohms). Check capacitor C6. Check for proper trigger (45-55 usec).
2. Low unit output	Reference error amplifier	Measure approximately 16 Vdc from cathode of VR3 (+) to TP1 (-). If 16 volts appears, replace IC4. If greater than 16 volts, replace VR3. If less than 16 volts, replace IC2 and/or VR3. At NO LOAD and at minimum rated output, measure approximately 9 Vdc from TP2 (+) to TP1 (-). DO NOT APPLY LOAD WITH TEST METER CONNECTED.
3. Output drifting	Refer to probable cause and remedy of symptom 2.	
4. Poor unit regulation	Refer to probable cause and remedy of symptom 2.	
5. OVP actuates repeatedly	A. Input rectifier	Check and replace if necessary.
	B. Refer to probable cause and remedy of symptom 2.	

diode in parallel with this resistance.

4. Connect the oscilloscope 10X probe positive lead to the base of the upper switching transistor (Q4), with the negative lead at the emitter. Set the oscilloscope sensitivity to 0.2V/division, timing to 20 usec/division and on the dc scale.

5. Clip the current probe to the common emitter lead of the switching transistors with the current direction (arrow) leaving the transistors into the main PCB. Set the oscilloscope sensitivity to 0.5A/division.

6. Momentarily apply, then quickly remove input power. Observe oscilloscope, and adjust as necessary for indication of a clean, square waveform on channel A. Repeat as necessary.

NOTE

Inability to obtain the waveform indicates a malfunction in the control PCB (refer to paragraph 5.4.4).

7. Place line power to ON. The unit should be working under deep current limiting mode. Check the following: (See waveform pattern "A", Figure 5-7).

   a. The oscillating square wave repetition should be from 45 to 55 microseconds.

   b. The peak level of the square waveform is at 0 volt, and the lower level is from (-)4 to (-)6.5 volts.

   c. No current will be detected by the current probe on channel B; only some very thin switching spikes of no significant magnitude should be evident.

8. Slowly adjust A100R38 CW. On the oscilloscope, the presence of a duty cycle will be observed. (See waveform patterns "B" and "C", Figure 5-7.) If A100R38 has no control over the duty cycle, check CR11/CR15 or C15.

9. Check that the current waveform in pattern "C" has twice the repetition rate of the voltage waveform "B", and also note that current pulses are reasonably similar in amplitude. If both of these events are not as stated, check the transistor drive circuit components.

NOTE

The procedure to this point verifies the proper functioning of the input drive and power transistor circuits. Continue only when the conditions of steps 7, 8 and 9 have been satisfied.

10. Re-insert Q3/Q4 (collector) screws. Connect a VOM, set to the R x 10K scale, from Q3/Q4 case to chassis. Read open circuit.

5.5.2 Final Calibration

If the switching transistors and/or drive circuit components have been changed, perform tests per paragraph 5.5.1 before continuing.

1. Remove input power and connect test equipment as in steps 4. and 5. of previous paragraph 5.5.1.

2. Connect the dc differential voltmeter and rms voltmeter across the output sensing terminals (TB1-1 and -4).

3. On front panel, set the output voltage control (R26) to its approximate mid-range, and the OVP control R14 fully CW.

4. Remove load from output.

5. Set current limit adjust (A100) R38 fully CCW.

6. Apply nominal input power and turn A100R38 slowly CW. The output voltage should increase and the current waveform on oscilloscope channel B should appear as in pattern "D" of Figure 5-7.

NOTE

At this point, three phenomena should be carefully watched:

   a. If there is a short in the power transformer (T1) primary winding, the current waveform will have alternate duty cycle pulses missing when the unit is out of cur-

rent limiting.

b. If there is a short at the secondary winding or at the output, the current will appear excessive. Normally, when the output is at no load the current observed on the oscilloscope should be no greater than 1.5 amperes.

c. If the unit oscillates with audible noise, attempt to tighter up the hold-down screws on output capacitor C19.

7. Apply full-rated load current. Set current limit control A100R38 at 115% of rated full-load current (per Table 1-1B/C).

8. Remove output load current. Set output voltage control R26 to 110% of rated output voltage (per Table 1-1B/C).

9. Slowly turn OVP control R14 CCW until it shuts the unit off.

10. Turn R26 at least one full turn CCW, and remove input voltage. After one minute, re-apply input, and adjust R26 for rated output.

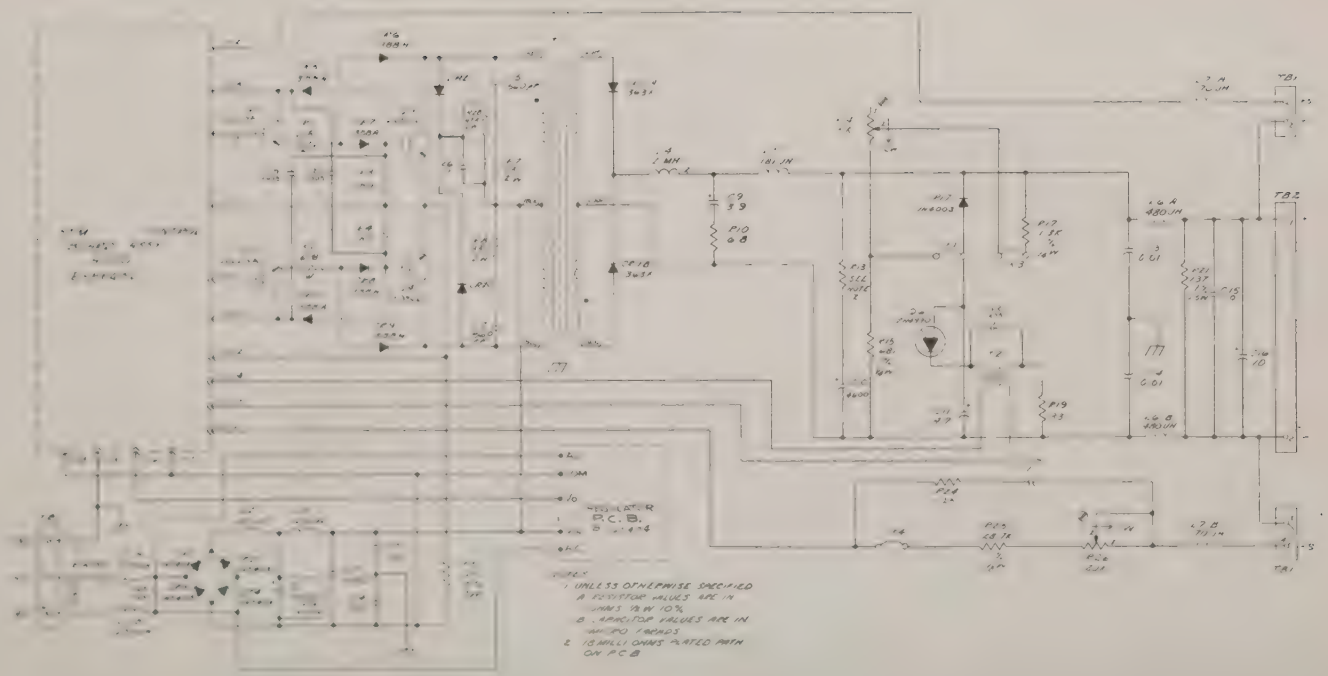

Figure 5-2 STM15-48-Volt Units
Typical Schematic Diagram

Table 6-1 Replaceable Parts, STM Module III

Ref Des	U/O Code	Description	Sorensen P/N	Mfr., Type
Capacitors (uF except as noted)				
C1	1-10	100, 200V	586052-1	STM, 91C
C2	1-10	1000, 200V	586052-1	STM, 91C
C3	1-10	0.02, 1KV	24-2029	SP, C023
C4	1-10	0.02, 1KV	24-2029	SP, C023
C5	1-10	560pF, 500V	235-7053P317	EMC, DM15
C6	1-10	1, 250V	24-2015-13	SE, MMK
C7	1-10	560pF, 500V	235-7053P317	EMC, DM15
C8	1-4	100, 25V	24-2279-14	SP, TE1211
C9	1,2	120, 10V	586057-8	UC, MIL-C-39003
	3,4	47, 20V	586385-8	UC, T110
	5-7	22, 35V	586058-23	UC, MIL-C-39003
	8	18, 50V	585071-44	UC, MIL-C-39003
	9,10	3.9, 75V	586386-5	UC, MIL-C-39003
C10	1-3,6-8	19,500, 25V	586043-2	STM, 91S
	4,5,9,10	4,600, 75V	586051-1	STM, 91S
C11	1-10	4.7, 10V	586057-2	UC, MIL-C-39003
C12		Not Used		
C13	1-10	0.01, 400V	587626-89	SE, Type 105
C14	1-10	0.01, 400V	587626-89	SE, Type 105
C15	1,2,6,7	0.1, 100V	587626-1	SE, Type 105
	3-5,8-10	0.22, 100V	587626-3	SE, Type 105
C16	1,6	120, 10V	586057-8	UC, MIL-C-39003
	2,7	47, 20V	586385-8	UC, T110
	3,4,8,9	22, 35V	586058-23	UC, MIL-C-39003
	5,10	18, 50V	586386-8	UC, MIL-C-39003
C17		Not Used		
C18	1-10	1, 100V	24-2037-19	SE, MMK
C19	1-10	0.003, 600V	235-7207P51	SP
C20	1-10	0.003, 600V	235-7207P51	SP
C21		Not Used		
C22	1-10	0.003, 600V	235-7207P51	SP
C23	1-10	0.22, 400V	587626-99	SE, Type 105
Diodes				
CR1	1-10	1N5403	26-1160-4	WH, 398
CR2	1-10	1N5403	26-1160-4	WH, 398
CR3	1-10	1N5403	26-1160-4	WH, 398
CR4	1-10	1N5403	26-1160-4	WH, 398
CR5	1-10	388A	586379-1	SEM, SS2993
CR6	1-10	388H	586379-6	SEM, SS2998
CR7	1-10	388A	586379-1	SEM, SS2993
CR8	1-10	388A	586379-1	SEM, SS2993
CR9	1-10	388H	586379-6	SEM, SS2998
CR10	1-10	388A	586379-1	SEM, SS2993
CR11	1-8,	Rectifier, 200V	586462-3	SEM, SCPA2F
	9,10	300V	586462-4	SEM, SCPA3F
CR12	1-4	1N4003	587565-2	SEM, S12
CR13	1-4	1N4003	587565-2	SEM, S12
CR14	1-4	1N4003	587565-2	SEM, S12
CR15	1-4	1N4003	587565-2	SEM, S12
CR16	1-4	1N4003	587565-2	SEM, S12
CR17	1-10	1N4003	587565-2	SEM, S12
CR18	1-10	Not Used		
CR19	1,2	Rectifier, 200V	586462-3	SEM, SCPA2F
CR20	1-10	388H	586379-6	SEM, SS2998
CR21	1-10	388H	586379-6	SEM, SS2998
Fuse				
F1	1-10	6A, 250V	42-415	BUS, MTH-6

Table 6-1 Replaceable Parts, STM Module III (cont'd)

Ref Des	U/O Code	Description	Sorensen P/N	Mfr., Type
Inductors				
L1	1-10	Coil, Toroid	586416-1	SR
L2	1,2	Choke Assy	586412-1	SR
	3,4		586412-2	SR
	5,6		586412-3	SR
	7,8		586412-4	SR
	9,10		586412-5	SR
L3	1,2	Choke Assy	586412-1	SR
	3,4		586412-2	SR
	5,6		586412-3	SR
	7,8		586412-4	SR
	9,10		586412-5	SR
L4	1,2	Choke Assy	586308-1	SR
	3,4		586308-2	SR
	5,6		586308-3	SR
	7,8		586308-4	SR
	9,10		586308-5	SR
L5	1,2	Choke Assy	586412-1	SR
	3,4		586412-2	SR
	5,6		586412-3	SR
	7,8		586412-4	SR
	9,10		586412-5	SR
L6	1,2	Choke Assy	586523-1	SR
	3,4		586524-1	SR
	5,6		586525-1	SR
	7,8		586526-1	SR
	9,10		586527-1	SR
L7	1-10	Choke Assy	586471-1	SR
Transistors				
Q1	1-10	2N2219A	386-7249P32	GE, 2N2219A
Q2	1-10	2N2219A	386-7249P32	GE, 2N2219A
Q3	1-4	2N3902	18-212-2	Delco, TO-3
	5-10	2N3902	18-212-1	Delco, TO-3
Q4	1-4	2N3902	18-212-2	Delco, TO-3
	5-10	2N3902	18-212-1	Delco, TO-3
Q5	1-4	2N2907A	386-7249P58	GE, 2N2907A
Q6	1-4	2N6027	386-7304P1	GE, 2N6027
	5-10	2N4990	586063-2	GE, 2N4990
Resistors (ohms, ±10% except as noted)				
R1	1-10	6.8, 1W	28-713	[illegible]
R2	1-10	6.8, 1W	28-713	[illegible]
R3	1-10	180, 1/2W	280-1145P47	[illegible]
R4	1-10	180, 1/2W	280-1145P47	[illegible]
R5	1,2	0.39, 7W, 5%	27-470-15	[illegible]
	3,4	0.33, 5W, 5%	586054-7	[illegible], T-5
	5-10	0.27, 7W, 5%	27-470-11	WL, Type 7XM
R6		Not Used		
R7	1-10	330, 2W	280-1147P56	[illegible]
R8	1-10	330, 2W	280-1147P56	[illegible]
R9	1-4	10, 1/2W	280-1145P2	[illegible]
R10	1,2	0.18, 3W	27-397-7	[illegible]
	3-5	0.56, 3W	27-397-19	[illegible]
	6-8	1.2, 3W, 5%	27-397-27	[illegible]
	9,10	6.8, 3W, 5%	27-397-45	[illegible]
R11	1-4	100, 1/2W	280-1145P38	[illegible]

Table 6-1 Replaceable Parts, STM Module III (cont'd)

Ref Des	U/O Code	Description	Sorensen P/N	Mfr., Type
Resistors (ohms, ±10% except as noted) (cont'd)				
R12	1,2	2700, 1/2W	28-2109	RC, 206F
	3,4	5600, 1/2W	28-2003	RC, 206F
R13		Not Used		
R14	1-8	Variable, 2K	586371-5	BNS, 3006P
	9,10	Variable, 5K	586371-6	BNS, 3006P
R15	1	5.36K, 1/4W, 1%	586250-109	ELA, MF4
	2-4	1300, 1/4W, 1%	28-1333	IRC, CEA-TO
	5,6,9,10	681, 1/4W, 1%	586250-66	ELA, MF4
	7,8	422, 1/4W, 1%	586250-56	ELA, MF4
R16	1-4	3.3K, 1/2W, 5%	280-1145P91	AB, EB
R17	1,2,9,10	1300, 1/4W, 1%	28-1333	IRC, CEA-TO
	3,4	7150, 1/4W, 1%	586250-115	ELA, MF4
	5,6	280, 1/4W, 1%	28-1284	IRC, CEA-TO
	7,8	422, 1/4W, 1%	586250-56	ELA, MF4
R18	1	5.36K, 1/4W, 1%	586250-109	ELA, MF4
	2-4	3320, 1/4W, 1%	586250-99	ELA, MF4
R19	1-10	33, 1/2W	280-1145P20	AB, EB
R20		Not Used		
R21	1	4.53, 25W, 3%	586369-511	RCL, AL-25
	2	15, 25W, 3%	586369-518	RCL, AL-25
	3	34.8, 25W, 3%	586369-526	RCL, AL-25
	4	75, 25W, 3%	586369-532	RCL, AL-25
	5	221, 25W, 3%	586369-538	RCL, AL-25
	6	2.8, 25W, 3%	586369-506	RCL, AL-25
	7	8.66, 25W, 3%	586369-187	RCL, AL-25
	8	24.9, 25W, 3%	586369-522	RCL, AL-25
	9	45.3, 25W, 3%	586369-529	RCL, AL-25
	10	137, 25W, 1%	586369-302	RCL, AL-25
R22		Not Used		
R23	2	1500, 1/8W, 1%	586055-185	ELA, MF4
	4	3480, 1/8W, 1%	586055-100	ELA, MF4
	6	2940, 1/8W, 1%	586055-186	ELA, MF4
	8	4990, 1/8W, 1%	586055-187	ELA, MF4
	10	13K, 1/8W, 1%	586055-189	ELA, MF4
R24	1	1.0K, 1/2W	280-1145P74	AB, EB
	2-10	1.2K, 1/2W	280-1145P77	AB, EB
R25	1,2	2940, 1/8W, 1%	586055-186	ELA, MF4
	3,4	5900, 1/8W, 1%	586055-111	ELA, MF4
	5,6	12.7K, 1/8W, 1%	586055-127	ELA, MF4
	7,8	18.7K, 1/8W, 1%	586055-135	ELA, MF4
	9,10	28.7K, 1/8W, 1%	586055-144	ELA, MF4
R26	1,2	Variable, 2K	586371-5	BNS, 3006P
	3-6	Variable, 5K	586371-6	BNS, 3006P
	7,8	Variable, 10K	586371-7	BNS, 3006P
	9,10	Variable, 20K	586371-8	BNS, 3006P
R27	1-10	0.18, 10W	27-590-7	WL, Type 12.5X
R28	1-10	47K, 2W	280-1147P134	AB, HB
R29	1-10	47K, 2W	280-1147P134	AB, HB
Transformers				
T1	1,6	Power	586280-1	SR
	2,7		586275-1	SR
	3,8		586292-1	SR
	4		586292-2	SR
	9		586292-4	SR
	5,10		586292-3	SR
T2	1-10	Pulse	586340-1	SR
VR1	1-4	Diode, Zener 1N825	588105-3	MA, 1N825

Table 6-2 Replaceable Parts, STM Module IIIA

Ref Des	U/O Code	Description	Sorensen P/N	Mfr., Type
Capacitors (uF except as noted)				
C1	1-10	1000, 200V	586052-1	STM, 91C
C2	1-10	1000, 200V	586052-1	STM, 91C
C3	1-10	0.02, 1KV	24-2029	SP, C023
C4	1-10	0.02, 1KV	24-2029	SP, C023
C5	1-10	0.001, 1KV	235-7421P14	RDM, JF
C6	1-10	680pF, 1KV	235-7421P10	RDM, JF
C7	1-10	0.001, 1KV	235-7421P14	RDM, JF
C8	1-4	100, 25V	24-2279-14	SP, TE1211
C9	1,2	220, 10V	586057-10	UC, MIL-C-39003
	3,4	100, 20V	586385-10	UC, T110
	5-7	47, 35V	586058-27	UC, MIL-C-39003
	8	18, 50V	585071-44	SP, 150D
	9,10	10, 75V	586386-8	UC, MIL-C-39003
C10A/B	1-6	19500, 25V	586043-2	STM, 91S
	7-10	4600, 75V	586051-1	STM, 91S
C11	1-10	4.7, 10V	586057-2	UC, MIL-C-39003
C12		Not Used		
C13	1-10	0.01, 400V	587626-89	SE, Type 105
C14	1-10	0.01, 400V	587626-89	SE, Type 105
C15	1-6	0.1, 100V	587626-1	SE, Type 105
	7,9	0.22, 100V	587626-3	SE, Type 105
C16	1,2	120, 10V	586057-8	UC, MIL-C-39003
	3,4	47, 20V	586385-8	UC, T110
	5-7	22, 35V	586058-23	UC, MIL-C-39003
	8	18, 50V	585071-44	SP, 150D
	9,10	10, 75V	586386-8	UC, MIL-C-39003
C17	1-4	0.22, 400V	587626-99	SE, Type 105
C18	1-10	1, 100V	24-2037-19	SE, MMK
C19		Not Used		
C20		Not Used		
C21	5-10	0.47, 35V	586058-3	UC, MIL-C-39003
C22	1-10	0.003, 600V	235-7207P51	SP
C23	1-10	0.22, 250V	24-2015-17	SE, MMK
C24	1-10	270pF, 500V	235-7053P297	EMC, DM15
Diodes				
CR1	1-10	Rectifier	588096-3	ST, G775-4
CR2		Not Used		
CR3		Not Used		
CR4		Not Used		
CR5		Not Used		
CR6		Not Used		
CR7		Not Used		
CR8		Not Used		
CR9		Not Used		
CR10		Not Used		
CR11	1-8	Rectifier, 200V	586462-3	SEM, SCPA2F
	9,10		586462-4	SEM, SCPA3F
CR12	1-4	1N4003	587565-2	SEM, S12
CR13	1-4	1N4003	587565-2	SEM, S12
CR14	1-4	1N4003	587565-2	SEM, S12
CR15	1-4	1N4003	587565-2	SEM, S12
CR16	1-4	1N4003	587565-2	SEM, S12
CR17	1-10	1N4003	587565-2	SEM, S12
CR18		Not Used		
CR19	1-7	Rectifier, 200V	586462-3	SEM, SCPA2F
CR20	1,2	Rectifier, 200V	586462-3	SEM, SCPA2F
	3-10	Not Used		
Fuse				
F1	1-10	8A, 125V	226-7176P54	BUS, 125VGLH

Table 6-2 Replaceable Parts, STM Module IIIA (cont'd)

Ref Des	U/O Code	Description	Sorensen P/N	Mfr., Type
Inductors				
L1	1-10	Coil, Toroid	586676-1	SR
L2	1,2	Choke Assy	586548-1	SR
	3,4		586548-2	SR
	5-7		586548-3	SR
	8		586548-4	SR
	9,10		586548-5	SR
L3	1,2	Choke Assy	586548-1	SR
	3,4		586548-2	SR
	5-7		586548-3	SR
	8		586548-4	SR
	9,10		586548-5	SR
L4	1,2	Choke Assy	586538-1	SR
	3,4		586538-2	SR
	5,6		586538-3	SR
	7		586538-4	SR
	8		586538-5	SR
	9,10		586538-6	SR
L5	1,2	Choke Assy	586548-1	SR
	3,4		586548-2	SR
	5-7		586548-3	SR
	8		586548-4	SR
	9,10		586548-5	SR
L6	1,6	Choke Assy	586523-1	SR
	2,7		586524-1	SR
	3,8		586525-1	SR
	4,9		586526-1	SR
	5,10		586527-1	SR
L7	1-10	Choke Assy	586471-1	SR
L8	1-10	Choke Assy	165604-1	SR
Transistors				
Q1		Not Used		
Q2		Not Used		
Q3	1-4	2N6308	589698-3	RCA
	5-10	65115	586150-1	RCA
Q4	1-4	2N6308	589698-3	RCA
	5-10	65115	586150-1	RCA
Q5	1-4	2N2907A	386-7249P58	GE
Q6	1-4	2N6027	386-7304P1	GE
	5-10	2N4987	586063-1	GE
Resistors (ohms, ±10% except as noted)				
R1	1-10	1K, 2W	280-1147P74	AB, HB
R2	1-10	22K, 7W	27-471-30	WL, Type 7X
R3	1-4	68, 1/2W	280-1145P47	AB, EB
	5-10	180, 1/2W	280-1145P47	AB, EB
R4	1-4	68, 1/2W	280-1145P47	AB, EB
	5-10	180, 1/2W	280-1145P47	AB, EB
R5	1,2	0.27, 6.5W, 5%	586054-6	RCL, T-5
	3,4	0.22, 6.5W, 5%	586054-5	RCL, T-5
	5-10	0.1Ω, 5W	27-470-7	WL, Type 7XM
R6	1-10	.2Ω, 6.5W, 5%	586054-41	RCL, T-5
R7	1-10	2Ω, 6.5W, 5%	586054-41	RCL, T-5
R8	1-10	2Ω, 6.5W, 5%	586054-41	RCL, T-5
R9	1-4	1Ω, 1/2W	280-1145P2	AB, EB
R10	1,2	0.1Ω, 3W	27-397-1	WL, Type 3X
	3,4	0.22Ω, 3W	27-397-9	WL, Type 3X
	5-8	0.56, 3W	27-397-19	WL, Type 3X
	9,10	3.3, 3W, 5%	27-397-37	WL, Type 3X

Table 6-2 Replaceable Parts, STM Module IIIA (cont'd)

Ref Des	U/O Code	Description	Sorensen P/N	Mfr., Type
Resistors (ohms, ±10% except as noted) (cont'd)				
R11	1-4	82, 1/2W	28-2000	AB, RC20OF
R12	1,2	2700, 1/2W	28-2109	RC, 206F
	3,4	5600, 1/2W	28-2003	RC, 206F
R13		Not Used		
R14	1-8	Variable, 2K	586371-5	BNS, 3006P
	9,10	Variable, 5K	586371-6	BNS, 3006P
R15	1-4	1300, 1/4W, 1%	28-1333	IRC, CEA-T0
	5,6,9,10	681, 1/4W, 1%	586250-66	ELA, MF4
	7,8	422, 1/4W, 1%	586250-56	ELA, MF4
R16	1-4	3300, 1/2W	280-1145P91	AB, EB
R17	1,2,9,10	1300, 1/4W, 1%	28-1333	IRC, CEA-T0
	3,4	7150, 1/4W, 1%	586250-115	ELA, MF4
	5,6	280, 1/4W, 1%	28-1284	IRC, CEA-T0
	7,8	422, 1/4W, 1%	586250-56	ELA, MF4
R18	1-4	3.3K, 1/4W, 1%	28-1326	IRC, CEA-T0
R19	1-10	33, 1/2W	280-1145P20	AB, EB
R20		Not Used		
R21	1	1.82, 50W, 3%	586677-502	RCL, AL-50
	2	2.80, 50W, 3%	586677-506	RCL, AL-50
	3	6.04, 50W, 3%	586677-514	RCL, AL-50
	4	10, 50W, 3%	586677-516	RCL, AL-50
	5	18.2, 50W, 3%	586677-519	RCL, AL-50
	6	20, 50W, 3%	586677-520	RCL, AL-50
	7	34.8, 50W, 3%	586677-526	RCL, AL-50
	8	45.3, 50W, 3%	586677-529	RCL, AL-50
	9	86.6, 50W, 3%	586677-568	RCL, AL-50
	10	121, 50W, 3%	586677-534	RCL, AL-50
R22		Not Used		
R23	2	1500, 1/8W, 1%	586055-185	ELA, MF4
	4	3480, 1/8W, 1%	586055-100	ELA, MF4
	6	2940, 1/8W, 1%	586055-186	ELA, MF4
	8	4990, 1/8W, 1%	586055-187	ELA, MF4
	10	13K, 1/8W, 1%	586055-189	ELA, MF4
R24	1-10	1K, 1/2W	280-1145P74	AB, EB
R25	1,2	2940, 1/8W, 1%	586055-186	ELA, MF4
	3,4	5900, 1/8W, 1%	586055-111	ELA, MF4
	5,6	12.7K, 1/8W, 1%	586055-127	ELA, MF4
	7,8	18.7K, 1/8W, 1%	586055-135	ELA, MF4
	9,10	28.7K, 1/8W, 1%	586055-144	ELA, MF4
R26	1,2	Variable, 2K	586371-5	BNS, 3006P
	3-6	Variable, 5K	586371-6	BNS, 3006P
	7,8	Variable, 10K	586371-7	BNS, 3006P
	9,10	Variable, 20K	586371-8	BNS, 3006P
R27	1-10	Thermistor	165541-1	KC, RL10007-1.31
R28	1-10	47K, 2W	280-1147P134	AB, HB
Transformers				
T1	1,2	Power	586513-1	SR
	3,4		586513-2	SR
	5,6		586515-1	SR
	7		586515-2	SR
	8		586515-3	SR
	9,10		586516-1	SR
T2	1-10	Pulse	586340-1	SR
VR1	1-4	Diode, Zener 1N825	588105-3	MA

Table 6-3 Replaceable Parts, Control PCB Ass'y 586423-2

Ref Des	Description	Sorensen P/N	Mfr., Type
C1	0.001, 1KV	235-7421P14	RDM, Type JF
C2	0.0015, 200V	24-2409-2	AX, V146XR
C3	220pF, 500V	235-7053P286	EMC, DM15
C4	220pF, 500V	235-7053P286	EMC, DM15
C5	220pF, 500V	235-7053P286	EMC, DM15
C6	6.8, 35V	586058-17	UC, MIL-C-39003
C7	100pF, 500V	235-7053P254	EMC, DM15
C8	0.15, 250V	24-2015-15	SE, MMK
C9	6.8, 35V	586058-17	UC, MIL-C-39003
C10	4.7, 10V	586057-2	UC, MIL-C-39003
C11	0.01, 200V	24-2409-7	AX, V146XR
C12	6.8, 6V	586384-2	UC, T110
C13	0.22, 100V	24-2037-11	SE, MMK
C14	15, 20V	586385-5	UC, T110
C15	6.8, 35V	586058-17	UC, MIL-C-39003
C16	15, 20V	586385-5	UC, T110
C17	0.001, 1KV	235-7421P14	RMD, Type JF
C18	0.001, 1KV	235-7421P14	RMD, Type JF
C19	0.001, 1KV	235-7421P14	RMD, Type JF
C20	15, 20V	586385-5	UC, T110
C21	2.2, 20V	586385-2	UC, T110
C22	0.015, 250V	24-2015-3	SE, MMK
C23	0.0022, 200V	24-2409-3	AX, V146XR
C24	0.015, 250V	24-2015-3	SE, MMK
C25	.0033, 200V	24-2409-4	AX, V146XR
C26	0.01, 25V	235-7426P1	RMD, Type M25

Rectifiers (Diodes)

CR1	2N5062, 100V, SCR	322-7243P3	MA, 2N5062
CR2-7	1N4003, 200V, IA	587565-2	SEM, S12
CR8-14	1N4148	322-7220P1	ITT, 1N4148
CR15	S2F	586379-1	SEM, SS2993
CR16/19	1N4003, 200V, IA	587565-2	SEM, S12
CR20/21	S16	587565-4	SEM, S16

Integrated Circuits

IC1	CA3086	386-7319P3	RCA
IC2	LM741CN	586372-2	Fairchild
IC3	Phototran-sistor	586463-1	TI, TIXL 111
IC4	LM741CN	586372-2	Fairchild
IC5	CA3086	386-7319P3	RCA

Transistors

Q1	2N6027	386-7304P1	GE
Q2	2N3440	386-7249P13	RCA
Q3	2N3440	386-7249P13	RCA
Q4	2N2222A	386-7249P57	RCA
Q5	2N2907A	386-7249P58	RCA
Q6	2N2907A	386-7249P58	RCA
Q7	2N2907A	386-7249P58	RCA
Q8	2N3638	18-143	Fairchild

Table 6-3 Replaceable Parts, Control PCB Ass'y 586423-2 (cont'd)

Ref Des	Description	Sorensen P/N	Mfr., Type
Resistors (ohms, 1/2W, ±10% except as noted)			
R1	390, 1/4W	280-1171P59	AB, CB
R2	33.2K, 1/4W, 1%	586250-147	ELA, MF4
R3	150, 1/4W	280-1171P44	AB, CB
R4	2.2K, 1/4W	280-1171P86	AB, CB
R5	47K, 1/4W	280-1171P134	AB, CB
R6	390K	280-1145P167	AB, EB
R7	100K, 1/4W	280-1171P146	AB, CB
R8	270K	280-1145P161	AB, EB
R9	390K	280-1145P167	AB, EB
R10	47K, 1/4W	280-1171P134	AB, CB
R11	2.2K, 1/4W	280-1171P86	AB, CB
R12	270	280-1145P53	AB, EB
R13	Not Used		
R14	10K, 6.5W, 5%	586054-61	RCL, T-5
R15	22K, 1W	280-1180P122	AB, CB
R16	1K	280-1145P74	AB, EB
R17	10K, 1/4W, 1%	586250-122	ELA, MF4
R18	15.4K, 1/4W, 1%	586250-131	ELA, MF4
R19	Variable, 10K	586370-7	BNS, 3389H
R20	470	280-1145P62	AB, EB
R21	1.3K, 1/4W, 1%	28-1333	IRC, CEA-TO
R22	22K	280-1145P122	AB, EB
R23	Variable, 10K	586370-7	BNS, 3389H
R24	53.6K, 1/4W, 1%	586250-157	ELA, MF4
R25	6.65K, 1/8W, 1%	586055-188	ELA, MF4
R26	2.2K	280-1145P86	AB, EB
R27	4.7K	280-1145P98	AB, EB
R28	390K	280-1145P59	AB, EB
R29	2.05K, 1/4W, 1%	586250-89	ELA, MF4
R30	2.87K, 1/4W, 1%	586250-96	ELA, MF4
R31	10K	280-1145P110	AB, EB
R32	1K	280-1145P74	AB, EB
R33	4.7K, 1/4W	280-1171P98	AB, CB
R34	3.3K, 1/4W	280-1171P91	AB, CB
R35	487, 1/8W, 1%	586250-59	ELA, MF4
R36	10K	280-1145P110	AB, EB
R37	3.9K, 1/4W	280-1171P95	AB, CB
R38	Variable, 10K	586370-7	BNS, 3389H
R39	10K	280-1145P110	AB, EB
R40	47K	280-1145P134	AB, EB
R41	27K, 1/4W	280-1171P125	AB, CB
R42	270	280-1145P53	AB, EB
R43	1.2K	280-1145P77	AB, EB
R44	220	280-1145P50	AB, EB
R45	2.2K	280-1145P86	AB, EB
R46	150	27-1113	IRC, BWH
R47	150	27-1113	IRC, BWH
R48	3.3K, 5%	280-1145P91	AB, EB
R49	3.3K, 5%	280-1145P91	AB, EB
R50	47, 1/4W	280-1171P26	AB, CB
R51	100K	280-1145P146	AB, EB
R52	47, 1/4W	280-1171P134	AB, CB
R53	270K, 1/4W	280-1171P161	AB, EB
R54	10K, 1/4W	280-1171P110	AB, EB
R55	Not Used		
R56	270K	280-1145P161	AB, EB
T1	Bias Transformer	589958-1	SP

Zener Voltage Regulators			
VR1	1N5234B	588101-9	MA
VR2	1N5230B	588101-6	MA
VR3	1N825	588105-3	MA
VR4	1N5230B	588101-6	MA
VR5	1N5234B	588101-9	MA

Table 6-4 Replaceable Parts, Regulator PCB Ass'y 165474-1

Ref Des	Description	Sorensen P/N	Mfr., Type
C1	Cap., 1uF, 350V Elect.	235-7397P152	SP, 30D
C2	Cap., 3uF, 150V Elect.	235-7397P143	SP, 30D
CR1	Rectifier, S16	587565-4	SEM, S16
CR2	Rectifier, S16	587565-4	SEM, S16
Q1	Transistor, T1P47	589802-1	TI, P47
Q2	Transistor, 2N3440	386-7249P13	RCA
R1	Resistor, W/W, 10K, 3W	27-398-18	WL, 3X
R2	Not Used		
R3	Resistor, 100K, 1/2W	585326-188	CG, C5
R4	Resistor, 8.2K, 1/2W	585326-140	CG, C5
R5	Resistor, Variable, 10K	586370-4	BNS, 3389H
R6	Resistor, 150K, 1/2W	280-1145P152	AB, EB
R7	Resistor, W/W, 10K, 3W	27-398-18	WL, 3X
VR1	Zener, 1N4741A, 10V	588102-8	MA

Table 6-5 Replaceable Parts, Base Drive PCB Ass'y 166088-1

Ref Des	Description	Sorensen P/N	Mfr., Type
C19	Cap., 0.003uF, 600V	235-7207P51	SP
C20	Cap., 0.003uF, 600V	235-7207P51	SP
Diodes			
CR1	388H	586379-6	SEM, SS2998
CR2	388H	586379-6	SEM, SS2998
CR3	S110	587565-6	SEM
CR4	S110	587565-6	SEM
CR5	388A	586379-1	SEM, SS2993
CR6	388H	586379-6	SEM, SS2998
CR7	388A	586379-1	SEM, SS2993
CR8	388A	586379-1	SEM, SS2993
CR9	388H	586379-6	SEM, SS2998
CR10	388A	586379-1	SEM, SS2993
Transistors			
Q1A	2N2219A, NPN	386-7249P32	GE
Q1B	2N2219A, NPN	386-7249P32	GE
Q2A	2N2219A, NPN	386-7249P32	GE
Q2B	2N2219A, NPN	386-7249P32	GE
Resistors			
R1A	12 ohms, 1/2W, 10%	280-1145P5	AB, EB
R1B	12 ohms, 1/2W, 10%	280-1145P5	AB, EB
R2A	12 ohms, 1/2W, 10%	280-1145P5	AB, EB
R2B	12 ohms, 1/2W, 10%	280-1145P5	AB, EB

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